THRUSTMASTER OF TEXAS, INC.
P.O. BOX 840189
HOUSTON. TEXAS 77284-0189

For A Big Thrust In The Right Direction

INSTALLATION, OPERATING AND MAINTENANCE MANUAL

AND

SPARE PARTS CATALOG

FOR

PROPELLING UNIT OUTBOARD, 180 HORSEPOWER

THRUSTMASTER PROJECT 92092

U.S. NAVY CONTRACT NUMBER

N68711-92-C-2065

INCLUDES DRAWINGS	D102069	
	D102037	
	D102024	W/PARTS LIST
	D101423	(REVISED)
	D101424	(REVISED)

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SECTION 1

HOW TO USE THIS MANUAL AND WARRANTY INFORMATION

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THRUSTMASTER OF TEXAS, INC.

WARRANTY PROVISIONS

THERE ARE NO WARRANTIES, EXPRESS OR IMPLIED, INCLUDING THE WARRANTY OF MERCHANTABILITY, EXCEPT AS SPECIFICALLY SET FORTH HEREIN. All new material furnished hereunder is warranted against any defect in materials or workmanship for 12 months from the date equipment is placed in service or 18 months from the date of shipment of equipment from our shop in Houston, Texas, whichever first occurs. Notwithstanding the foregoing, Thrustmaster of Texas, Inc.'s warranty does not extend to components manufactured by others. As to such components, only the component manufacturer's warranty shall apply.

Warranty claims are to be made by requesting a written returned goods authorization from Thrustmaster of Texas, Inc., and, upon its receipt by Customer shipment of the affected equipment to Thrustmaster of Texas, Inc., F.O.B. our Houston, Texas, facility. In the event Customer wishes to make a warranty claim but not to ship the affected equipment to Thrustmaster of Texas, Inc., Customer shall issue a time and materials purchase order to Thrustmaster of Texas, Inc. Customer shall pay for travel time, travel expenses, and other expenses incurred by Thrustmaster of Texas, Inc. in resolving the claim but not for materials and labor expended in work directly on the equipment and which Thrustmaster of Texas, Inc. determines to be within the terms of the above warranty. The above warranty shall be void if components are replaced, removed, disassembled, remodeled or adjusted without prior authorization from an authorized representative of Thrustmaster of Texas, Inc.

Thrustmaster of Texas. Inc.'s obligation on any claims is limited to replacement or repair of the defective part or material, F.O.B. our shop, Thrustmaster of Texas, Inc. in Houston, Texas. Except as above stated, Thrustmaster of Texas, Inc. will not be liable for any loss, injury, or damages to persons or material or equipment furnished hereunder or delay in performance of this agreement, nor will Thrustmaster of Texas, Inc. be liable for direct, indirect, special or consequential damages of any kind sustained by Customer from any cause.

THRUSTER WARRANTY CLAUSE

Thrustmaster of Texas, Inc. manufactured thrusters have been designed to operate according to our published specifications, which require that the thruster be installed with a Thrustmaster of Texas, Inc. Hydraulic System that has been specifically designed for troublefree operation.

All Thrustmaster of Texas, Inc. published warranties are cancelled, null, and void if the purchaser elects not to purchase the Thrustmaster of Texas, Inc. Hydraulic System, uses any other hydraulic system that has not been approved by Thrustmaster of Texas, in writing, or if the hydraulic system is not properly flushed according to Thrustmaster of Texas, Inc. published flushing specifications.

MERGER

Thrustmaster of Texas. Inc.,'s representatives may have made oral statements about the merchandise described in this contract. Such statements do not constitute warranties, shall not be relied on by customer, and are not part of the contract of sale. The entire contract is embodied in this writing. This writing constitutes the final expression of the parties' agreement, and it is a complete and exclusive statement of the terms of that agreement.

SECTION 2

INTRODUCTION AND TECHNICAL DESCRIPTION OF EQUIPMENT

INTRODUCTION

I. EQUIPMENT:

The equipment covered by this manual consists of a self-contained, deck-mounted marine propulsion unit. The unit is designed to propel and position work boats, barges or maintenance vessels in inland water.

The unit consists of a skid-mounted package for installation on a steel deck. An outdrive assembly is suspended from the end of the skid provided with a propeller for the propulsion or positioning of a vessel. The outdrive is steerable through 360o without stop. The propeller speed can be controlled from standstill to maximum speed both in forward and reverse directions. The outdrive can be kicked up out of the water through an angle of 180o to facilitate easy inspection, maintenance and transportation of the unit. Unit is fully operational, without limitations, at any degree of kick-up and at any angle of steering.

II. PRINCIPAL COMPONENTS AND SPECIFICATIONS:

Power Source:	Detroit Diesel Model 6-71
Rated Horsepower:	180 BHP Continuous
Rated Engine Speed:	1800 RPM
Rated Propeller Speed:	430 RPM
Propeller Diameter:	42 x 34
Rated Steering Speed:	4 RPM

III. PRINCIPLES OF OPERATION

The diesel engine drives a variable displacement axial piston hydrostatic transmission pump. This pump is furnished with a controller which adjusts the pump swashplate controlling the stroke of the pistons. In neutral swashplate position, the pistons have zero stroke and the pump does not displace any volume of oil, regardless of its shaft speed. When moving the swashplate in either direction, the pump will start flowing oil in the direction corresponding to the direction in which the swashplate is moved. The amount of flow is proportional to the angle of movement of the swashplate.

The hydraulic oil flows through high pressure hoses to a hydraulic propulsion motor driving the propeller shaft. The higher the flow pumped through the propulsion motor, the faster the propeller will turn. Accordingly, control of the pump swashplate will provide infinite speed control of the propeller.

It should be noted that the hydraulic flow is also proportional to the diesel engine speed. Accordingly, propeller speed can be controlled either by setting the engine speed constant and manipulating the pump swashplate or by leaving the pump swashplate at a fixed angle and varying the diesel engine speed.

Steering and kick-up of the outdrive is operated by a separate open loop hydraulic system powered by a separate pump piggyback mounted to the main pump. Steering is electric over hydraulic, controlled by a joystick lever switch on the control panel.

The joystick activates a hydraulic solenoid operated control valve on the unit which provides hydraulic power to the hydraulic steering motor in the upper outdrive housing. The steering is normally locked by a spring energized multi-disc brake. Whenever the steering motor is activated by the steering joystick lever in the wheelhouse, the brake is automatically released. The brake resets as soon as the joystick is returned to its neutral position.

Power kick-up is controlled by a solenoid operated directional control valve installed on the power unit. The valve is operated by pushbuttons on the control panel.

All hydraulic systems are protected by hydraulic reliefs or hydraulic compensators. Main propulsion is protected by a fast-acting hydraulic compensator which forms an integral part of the main pump. It is set at 3000 psi. The pump will automatically destroke whenever the pressure reaches 3000 psi. This condition would occur when the propeller gets blocked by an obstacle or gets tied up in a rope.

The auxiliary system is provided with a relief valve incorporated in the control valve, set at 2000 psi. A separate relief valve is installed in the push side of the kick-up rams. The reliefs will allow the outdrive to kick-up whenever it hits an obstacle.

SECTION 3

INSTALLATION PROCEDURES

IV. INSTALLATION INSTRUCTIONS

The unit is pre-packaged as a self-contained unit. It can be bolted directly to the pads on the deck of the vessel.

The outboard propulsion unit is furnished with six support feet.

The total weight of the outboard propulsion unit is approximately 11,000 pounds.

Three-quarter inch diameter grade 8 bolts are recommended for mounting of the propulsion units to the deck supports.

SECTION 4

OPERATING INSTRUCTIONS

OPERATION:

INTRODUCTION:

Your Thrustmaster outboard propulsion unit is designed for many years of trouble-free operation. While extreme care has been taken during the manufacturing and assembly of the equipment at the manufacturer's workshop, it is not unusual that minor problems are experienced during initial operation. This may be due to running in of the components, initially tight clearances, assembly dirt in the machinery or assembly errors undetected during factory testing. It is therefore recommended that extra care be taken during the initial operation of the equipment. Do not over-speed, over-load or over-burden the equipment initially in any way. Give the equipment some time to wear in and give the filters some time to clean the fluids and pay special attention to all indicators during the first 200 hours of operation.

The operator should first familiarize himself thoroughly with the equipment. Open the doors of the power unit and thoroughly inspect the equipment. Always watch for leaks. Hydraulic systems do not need to leak. Fix leaks immediately as they occur. Refer to the maintenance section of this manual for proper repair procedures.

BEFORE STARTUP

1. Check the fuel level in the fuel tank. The fuel tank is contained in the whole lower section of the skid. The fuel level gauge is located on the deck of the skid. The filler cap is immediately adjacent to the level gauge. Add fuel as required.

2. Check lube oil level in the diesel engine. The engine lube oil dipstick is on the starboard side of the engine. Add lube oil as required. Select oil in accordance with the diesel engine instruction manual.

3. Check fluid level in the engine radiator. Add engine coolant as required through the filler cap mounted on top of the radiator. Use an approved anti-freeze/water mixture in accordance with the diesel engine instruction manual.

WARNING

The radiator cap is a pressure cap. Never attempt to open the radiator cap when the engine is still hot or when the radiator feels warm. Severe burns may result.

4. Check the hydraulic oil level in the hydraulic reservoir. The level gauge is located on the port side of the unit. The level gauge should be filled almost to the top of the sight glass. Please note that the sight glass is a combined level and temperature gauge. The hydraulic oil used at the factory is Mobil EAL 224H which is a premium biodegradable vegetable based hydraulic oil. Never mix hydraulic oils of different brands or grades.

CAUTION

Cleanliness of the hydraulic system is of extreme importance. Whenever hydraulic oil is added, be sure to pump the oil through a 10-micron filter while filling the reservoir. Never assume that oil from a new drum is filtered.

5. Check for any obvious damage or leaks and make repairs or adjustments as required.

6. Make sure that the pump swashplate is in its neutral position. This means that the pump lever on the control station must be in its center position.

Controls and Instrumentation

1. Local Controls

The ammeter displays the electrical current. A negative current indicates that the battery is running down. A positive current indicates that the charging alternator is charging the battery. During normal operation, the current should always be positive. A negative current is an indication of either a wiring short or a malfunctioning of the charging alternator.

The hydraulic charge pressure gauge displays the charge of the main hydrostatic transmission system. It is normally around 300 psi and should never fall below 200 psi. Lack of sufficient charge pressure is an indication of a major hydraulic system failure and the unit must be shut down immediately if this occurs.

The main hydraulic system pressure gauge displays the main hydraulic power pressure used for propulsion energy, both in forward and reverse propulsion mode. In neutral swashplate position, this pressure will be equal to the charge pressure. At maximum swashplate position and rated engine speed, the pressure should be around 2800 psi. Main pressure should never exceed 3200 psi as this is the relief pressure and the compensator pressure. If the gauge shows 3200 psi and the propulsion unit does not appear to be powerful, the propeller is blocked by an object such as a rope entangled in the propeller.

The auxiliary system pressure gauge displays the oil pressure used for steering, and kick up. While not using the steering joy stick or the kick up or ramp control levers, the auxiliary pressure gauge should display approximately 300 psi. While steering, the pressure may vary between 1500 and 2000 psi. During kick up of the unit, the pressure may vary between 1000 and 2000 psi. The auxiliary pressure cannot exceed 2000 psi as that is the relief valve setting.

The indicators on the filters should always be in the green zone during operation. When they are in the red zone, the unit must be shut down and the filter element replaced before resuming operation.

2. Remote Controls

The key switch on the remote panel energizes the electrical system. The key switch should be turned to the ON position prior to starting of the unit. It should be returned to the OFF position after the unit has been shut down.

The start button will crank the diesel engine. Depress the start button until the tachometer shows an engine speed of 500 RPM. If the engine fails to start within 30 seconds, release the start button and allow the battery and the starting motor to cool a few minutes before trying again. If the engine fails to start after 4 attempts, an inspection should be made to determine the cause of the problem.

CAUTION

To prevent serious starting motor damage, do not try to start the engine again after the engine has already started.

The stop button is used to kill the engine. During normal stopping, first put the propeller speed control lever in its NEUTRAL position. Allow the engine to run at low idle speed for 4 to 5 minutes to allow the engine to cool down. Then depress the stop button until the engine has come to a complete stop.

The diesel engine throttle control lever controls engine speed from low idle to full throttle. Low idle speed is approximately 700 RPM. Full rated speed is 1800 RPM. Do not use the equipment at engine speeds above 1800 RPM. Note that because of the hydraulic transmission of the propulsion unit, increased engine speed will not provide increased power to the propeller. Full propulsion power is obtained at an engine speed of 1800 RPM. Higher engine speeds will not increase propulsion power. Speeds in excess of 1800 RPM will result in increased wear and reduced service life of the equipment.

The pump swashplate control joystick is on the side of the panel. It controls the hydraulic oil flow of the main hydraulic pump. In the center position of the lever, the pump swashplate is in its neutral position and pump flow is zero. Accordingly, in the neutral lever position the propeller will not turn. Moving the control lever forward will cause the pump to flow oil in forward direction causing the propeller to turn in forward direction. Pulling the lever backward from its neutral position will cause the propeller to start rotating in reverse. The pump control lever is proportional. Full forward position will result in maximum forward propeller speed and full reverse position of the lever will result in maximum reverse propeller speed. This is based on full engine speed. At partial engine speed, the propeller speed will also be partial even with the pump lever at full position.

It is recommended that during normal operation of the propulsion unit, the engine is set at a fixed speed depending on weather conditions, current conditions and power requirements of the mission. For instance, the engine speed may be set at 1500. Maneuvering, i.e., full power, 3/4 power, half power, reverse, etc. can then be controlled with the propeller speed control lever. Note that it is allowable to move the propeller speed control lever from full forward to full reverse without reducing engine speed.

The steering position indicator displays the steering angle of the outdrive. Zero degrees corresponds to normal forward steering direction similar to a rudder indicator. The outdrive is steerable through 360o without stop.

The steering joystick will cause the outdrive to steer. Moving the joystick left will cause the propulsion unit to rotate in a counterclockwise direction. Moving the joystick to the right will cause the outdrive to rotate in a clockwise direction. The steering control is provided with automatic ramping. This means that the outdrive will start to turn slowly and will not attain full steering speed until after approximately 300 milliseconds. When returning the steering joystick to its neutral position, the outdrive will stop steering within 300 milliseconds.

Otherwise, steering speed is constant at approximately 4 revolutions per minute regardless of engine speed. The steering speed can be adjusted by adjusting the flow control at the steering solenoid valve. The flow control is mounted between the control valve manifold and the steering solenoid valve. It has an adjusting screw (socket head set screw) and a lock nut. To adjust the steering speed, loosen the lock nut and while holding the lock nut with a wrench, screw the adjusting screw in to reduce steering speed or out to increase steering speed, using an allen wrench. Re-tighten the lock nut.

The cooling water temperature alarm lights will be lit whenever the engine coolant temperature exceeds 210oF. The unit should be shut down immediately.

The alarm light will also be lit whenever the engine oil pressure is below 15 psi. This will always occur when the power switch is in the ON position, before starting the engine. It will also occur when operating, during loss of oil pressure. The engine should be shut down as soon as safely possible to correct the problem.

The panel light dimmer control knob proportionally controls the intensity of the back lighting of the indicators on the panel. Back lighting is automatically on whenever the key switch of any of the units is in the on position.

3. Automatic Shutdown System

A low hydraulic oil level in the hydraulic reservoir will cause the engine to shut down. The hydraulic oil level must be increased to its normal operating level before the unit can be restarted. The engine will also shut down automatically upon loss of engine oil pressure or excessive cooling water temperature.

CAUTION

The engine automatically shut-down system cause the engine outlet air box valve to close. The valve must be manually reset on the engine, before the engine can be started again.

Before Start-Up

1. Check lube oil level in the diesel engine. Add lube oil as required. Select oil in accordance with the diesel engine instruction manual.

2. Check fluid level in the engine expansion tank. Add engine coolant as required through the filler cap mounted on top of the tank. Use an approved antifreeze/water mixture in accordance with the diesel engine instruction manual.

3. Check the hydraulic oil level in the hydraulic reservoir. The level gauge should be filled almost to the top of the sight glass. Please note that the sight glass is a combined level and temperature gauge. The hydraulic oil used in the factory is Mobil EAL-224H which is a premium biodegradable hydraulic oil. Never mix hydraulic oils of different brands or grades.

CAUTION

Cleanliness of the hydraulic system is of extreme importance. Whenever hydraulic oil is added, be sure to pump the oil through a 10-micron filter while filling the reservoir. Never assume that oil from a new drum is filtered.

4. Check for any obvious damage or leaks and make repairs or adjustments as required.

5. Before initial startup of the equipment, fill the main hydraulic pump case with filtered hydraulic oil through the pump case drain connection, after removing the hydraulic case drain hose which is the hose that goes to the return filter.

6. Make sure that the pump swashplate is in its neutral position. This means that the propeller speed control lever on the control station must be in its center position.

Initial Start-up

1. Be sure to make all checks before start-up, as listed earlier in this chapter.

2. Make sure that the engine throttle lever is at IDLE and the propeller speed control lever is in NEUTRAL on the wheelhouse control panel.

3. Turn the start key and run the engine at idle speed.

4. Watch the charge oil pressure gauge. It should go up to approximately 300 psi. If the system is not completely filled with hydraulic oil, it may take up to 30 seconds to develop charge pressure. Check the reservoir level gauge to see if filling the system drew the level down. Add oil as required.

CAUTION

A lack of charge pressure indicates failure of the equipment. Shut down immediately and correct the problem before restarting.

5. Check engine oil pressure. Oil pressure should almost immediately go up to approximately 35 psi.

CAUTION

A lack of engine oil pressure indicates lack of lubrication of the engine. Even though the engine is provided with an automatic shutdown for low oil pressure, shut the engine down manually when oil pressure remains insufficient. Correct the problem before restarting.

6. Let the unit run at low idle speed for approximately 30 minutes. Watch for any leaks and make corrections where necessary. Continuously monitor the pressure and temperature gauges as well as the reservoir hydraulic oil level gauge. Also make sure that the ammeter indicates that the batteries are being charged. With the engine still running at idle speed, start operating the steering, and kick-up. Initially there may be air in the system which may cause jerky operation. Bleed the air out at high spots and continue to operate the controls until steering, and kick-up operations perform smoothly and consistently.

7. Increase engine speed gradually to 1800 RPM and continue to work steering and kick-up controls. Continue to monitor all pressures, temperatures and levels and watch for leaks.

8. Move propeller speed control lever to approximately 25% forward. Charge pressure may drop down somewhat, but should never drop below 200 psi. Main pressure should increase to approximately 500 to 1000 psi. Let the unit run in this position for at least 2 hours. Continue to check for leaks.

9. Move the pump control lever to full forward. Main pressure should increase to approximately 2800 psi. Charge pressure should remain unchanged. Check for leaks.

10. Continue to monitor all gauges. Engine should be at full operating temperature. The hydraulic oil should also be at full operating temperature which is approximately 120oF. Maximum hydraulic oil temperature is 140oF. The temperature gauge is integral with the level gauge on the hydraulic reservoir.

11. The unit is now at full flow. Check the suction filter indicator. Also check the local indicator on the hydraulic return filter. If the indicator is in the red, the filter element must be replaced.

SECTION 5

MAINTENANCE PROCEDURES

MAINTENANCE

Routine Maintenance Instructions

For engine routine maintenance, please refer to the diesel engine service manual and operators guide.

For pump routine maintenance, please refer to the pump maintenance manual.

Cooling System. Both the engine coolant and the hydraulic oil are water cooled. Sea water is pumped up by the engine raw water pump and is pumped through the engine heat exchanger and hydraulic oil heat exchanger. It is then returned to the sea.

CAUTION

Make sure cooling water is discharged through the PVC return pipe al all times when the engine is operating.

Inspect the heat exchangers monthly and check for leaks. Clean as required.

The hydraulic system. Main propulsion, steering and kick-up functions of this outboard propelling unit are all hydraulic. The hydraulic system is therefore of extreme importance. It does not require much maintenance, but certain factors must be carefully considered, as follows:

1. Use premium quality hydraulic oil. Thrustmaster recommends the use of Mobil EAL 224H hydraulic oil for your application. This is what was used when originally filling up the reservoir. The propulsion unit has an oil capacity of approximately 50 gallons. Never mix different brands of hydraulic oil or different grades of hydraulic oil. The hydraulic oil recommended is based on ambient temperatures normal to the southern parts of the United States. When using the units under substantially different climactic conditions, a different hydraulic oil should be used in accordance with ambient temperatures prevailing at that site.

2. Cleanliness of hydraulic oil is of extreme importance. The hydraulic system is provided with a 100 mesh suction strainer inside the reservoir. This suction strainer should be removed from the reservoir and cleaned every 20,000 hours of operation. The suction strainer is provided with an internal bypass set at 3 psi. The hydraulic reservoir must be drained before the suction strainer can be removed.

The pump is provided with a 10-micron charge filter. A filter indicator is mounted on the side of the filter head. The filter is provided with a 25 psi internal bypass. The filter element must be replaced after the first 50 hours of operation, then after then next 200 hours of operation and subsequently after each 1000 hours of operation or as required as indicated by the filter gauge. The best time to read the gauge is as soon as the engine is at full speed. The pump control lever may be in neutral position. Note that the reservoir is provided with a 3 psi pressure cap. As the hydraulic oil warms up, the pressure in the reservoir will rise and the suction filter indicator will start showing less of a vacuum and more of a positive pressure. Therefore, for proper reading interpretation, be sure to read the filter gauge as soon as the engine attains full speed. Note that whenever the bypass is open, the filter is no longer functional and dirt may enter the pumps which may cause serious damage.

The hydraulic system is also provided with a return filter. It is provided with a differential pressure indicator. As soon as the indicator goes into the red zone, the filter needs replacement.

Filter replacement can only be done while the unit is shut down.

3. Water in the hydraulic oil is detrimental to the performance of the equipment and will result in internal corrosion of pumps, valves and motors. Regularly inspect the color of the oil. Cloudy-looking oil indicates a high water content and the complete oil fill must be replaced. The hydraulic reservoir is provided with a 3 psi pressure filler cap so as to reduce breathing to a minimum. Air is often moisture laden and frequent opening of the reservoir filler cap will allow moist air to enter the reservoir resulting in water condensation inside the reservoir. When filling the reservoir or adding hydraulic oil, monitor the color of the oil pumped into the reservoir. Sometimes drums containing hydraulic oil contain water in the bottom of the drum.

CAUTION

After opening a new drum of oil, always store it in the horizontal position. Storage upright will allow the top to collect and retain rainwater and condensation which may leak into the oil drum. After opening a drum, be sure to reseal it securely to prevent dirt or water from entering the drum and contaminating the remaining oil in the drum.

4. Always watch for hydraulic oil leaks. Most hydraulic fittings and hoses used either use O-ring type flange connections, O-ring type threaded connections, or 37o flared connections. None of these connections require special sealants, such as Locktite (brand name). Whenever an O-ring fitting leaks, replace the O-ring and lubricate the O-rings with some O-ring grease. Whenever a 37o flared fitting (JIC) leaks, thoroughly inspect the surface of the flare. Scratches or dents will inhibit its sealing ability and replacement of the component is necessary. Whenever a pipe thread fitting (NPT) leaks, clean the threads and apply Loctite hydraulic sealant to the threads.

Never use pipe dope or teflon tape. The loctite hydraulic sealant requires setting for approximately 24 hours before applying hydraulic pressure.

When replacing hoses or fittings, be sure to thoroughly clean the internal of the hose or fitting before installation.

Fuel reservoir

The fuel reservoir consists of the full bottom section of the skid. Fuel capacity is approximately 60 gallons.

The fuel reservoir is provided with a pressure cap to minimize breathing and entrance of moisture. Do not open the reservoir unless necessary for refueling. The fuel gauge is immediately adjacent to the filler cap on the starboard side of the unit. The fuel pickup tube extends into a sump on the bottom of the reservoir. Because of its location, it is able to fully empty the reservoir before the engine runs out of fuel. Note that whenever the engine has run out of fuel, the fuel system must be re-primed before the engine will restart. Regular replacement of fuel filters is required in accordance with the diesel engine instruction manual.

The fuel sump will collect dirt and water. On the bottom of the skid in either side of this sump, 3/4 NPT drain plugs are provided. These plugs allow for draining of the fuel reservoir. However, as they are located on the bottom of the fuel sump, the drain openings can be used to drain off any accumulated water and dirt. Regular bleeding of these plugs is therefore recommended.

Electrical systems.

Electrical power is provided by the battery which is located on the skid inside the power unit. The system is 12 volt DC. The electrical power system is controlled with a power switch on the control panel. The main power switch is fused with a 20 amp fuse. The fuses are of the standard 1-1/4" long inline design.

All electrical readout instruments are on the control console. The engine is provided with a stop solenoid which closes the air supply. This solenoid is energized by the automatic shut down relay which is contained inside the control console. Automatic shut down will occur at:

1. Low hydraulic oil level. The hydraulic level switch is located inside the hydraulic oil reservoir and the electrical connections come out through the top of the hydraulic oil reservoir.

2. Low lube pressure.

3. High engine coolant temperature. The airbox valve must be manually reset before the engine can be restarted.

The tachometer signal generator is a voltage pulse generator installed on the starboard rear camshaft cover. It uses a .187" drive key.

The signal for the steering position indicator is provided by a transmitter installed in the upper outdrive housing.

Outdrive

The outdrive is provided with 3 grease zerks. One grease zerk is provided on the lower steering pinion bearing housing which is on the bottom of the upper outdrive housing. Two more grease zerks are on the bottom of the upper outdrive housing to lubricate the main steering bearing and the main steering seal. Regrease these grease zerks regularly.

When loss of hydraulic oil is observed while there are no obvious leaks, the leak may be inside the outdrive. On the bottom of the upper outdrive housing is a large drain plug. Remove the drain plug and see if the housing is dry inside. If hydraulic oil leaks out, there is a hydraulic leak in the outdrive.

Detailed Maintenance Procedures

For detailed maintenance procedures for the diesel engine and the main pump, please refer to the applicable engine and pump service manuals.

Detailed maintenance procedures for the outdrive are as follows:

5-30. REPAIR/REPLACE UPPER OUTDRIVE HOUSING ASSEMBLY

This Task Covers: a. Repair b. Replacement

INITIAL SETUP

Tools Required

Tool Kit, General Mechanics
(Appendix B, Item 1)

Equipment Conditions

Engine Shutdown (para 2-11).
Battery Disconnected (para 4-58).
Lift Cylinders Removed
(para 5-32).

Materials/Parts Required

Cotton Rags (Appendix E, Item 3)
Cover P/N D100314
Cover P/N d100315
Swivel P/N 69520FB20-FB20
Swivel P/N 9S12J12-012
Swivel P/N 9S6J8-08
Packing P/N P05055
Packing P/N P05053
Hose Assembly
P/N J4HU1212RC9010NJ-18
Adapter P/N 849-FSO-10X10
Packing P/N P05054
Hose Assembly
P/N J4HU1212RC99012RC90-14.5-190
Tube P/N C100353
Swivel Assembly
P/N D100326
Hose Assembly
P/N J4HU0808RC9010RC90-10.5-30
Hose Assembly
P/N JHU0808RC9010RC90-25.5-300
Fitting P/N P10004
Plug P/N P10007
Cap P/N MS25043-18D
Connector
P/N MS3102R-18-12S
Motor P/N RE240804
Key P/N P06002
Link P/N P08043
Chain P/N P08042
Shaft P/N C100324
Indicator P/N P04130
Cylinder Assembly
P/N TH5036048PA-00
Packing P/N 10033
Cup P/N 10026

Personnel Required

3 Persons

Packing P/N 10055
Retainer P/N 10085
Ring P/N 10714
Seal P/N 10008

REPAIR Repair is limited to the replacement of defective parts.

REPLACEMENT (Figure 5-27.)

1. Loosen and remove bolts (5) and washers (6).
2. Remove back cover (4).
3. Disconnect hoses (14), (8), (12), and (13).
4. Loosen and remove bolts (10) and washers (9).
5. Separate upper outdrive housing assembly (7) from lower section (11).
6. Remove O-ring (15).
7. Remove position indicator (para 4-50).
8. Loosen and remove bolts (2) and washers (3).
9. Remove top cover (1).
10. Loosen and remove bolts (16).
11. Remove screw (19) and washer (18) to remove fitting (17).
12. Remove seals (20) and (21).

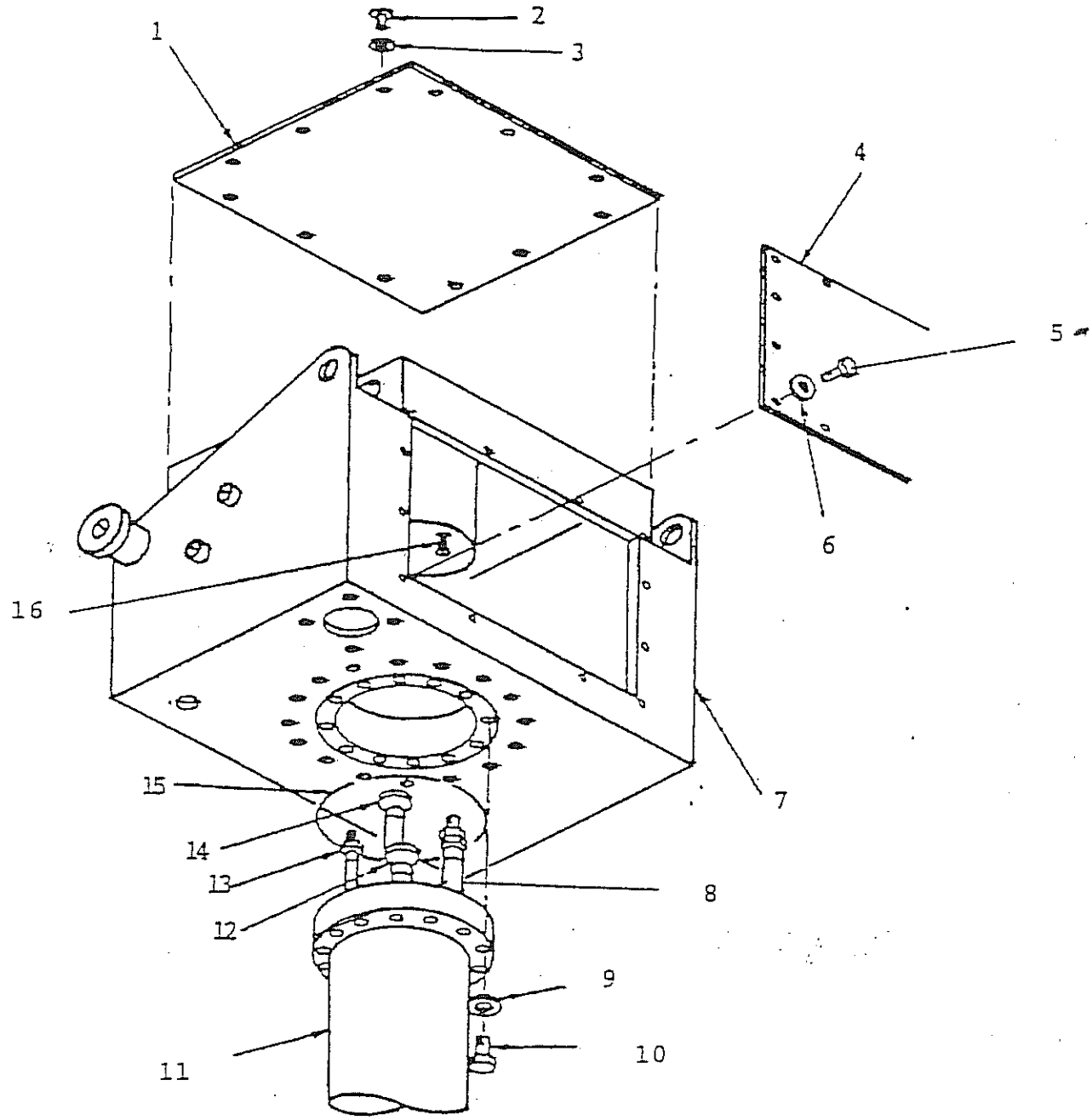


Figure 5-27 (1 of 3). Upper Outdrive Housing Assembly

13. Loosen and remove bolts (23) and washers (22).

14. Loosen and remove screws (26) and washers (25).

15. Remove protective cover (27) and bearing (28).

16. Remove steering motor assembly (para. 4-49).

17. Remove pinion (29).

18. Remove drain plug (30).

19. Remove swivels (31) and (32).

20. Loosen and remove bolts (33) and washers (34) to remove plate (35).

21. Loosen and remove bolts (36) and (93) and washers (37) and (42) to remove tubing assemblies (41).

22. Remove hoses (44) and (46).

23. Pull swivel stator (45) from rotor (38).

24. Remove four seals (40) and two bearings (39).

25. Loosen and remove bolts (53) and washers (52) to remove retainer plate (51).

26. Loosen and remove bolts (50) and washers (49).

27. Adapter (48) and gear (47) can now be removed.

28. Install gear (47) and adapter (48).

29. Install bolts (50) and washers (49).

30. Install retainer plate (51).

31. Install washers (52) and bolts (53).

32. Install bearings (39) and seals (40).

33. Install rotor (38) into stator (45).

34. Install hoses (44) and (46).

35. Install tubing assemblies (41).

36. Install washers (37) and (42) and bolts (36) and (93).

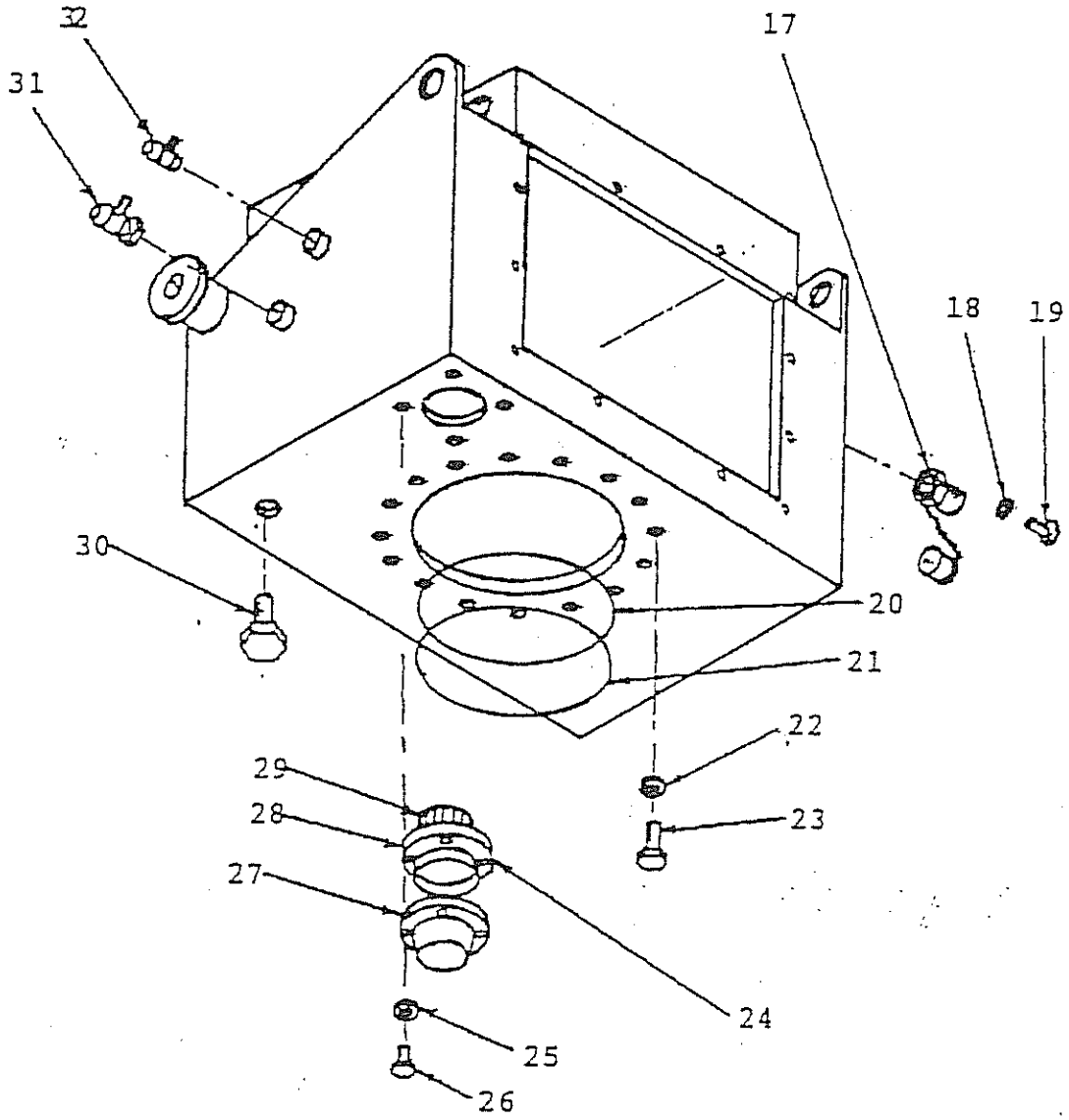


Figure 5-27 (2 of 3). Upper Outdrive Housing Assembly

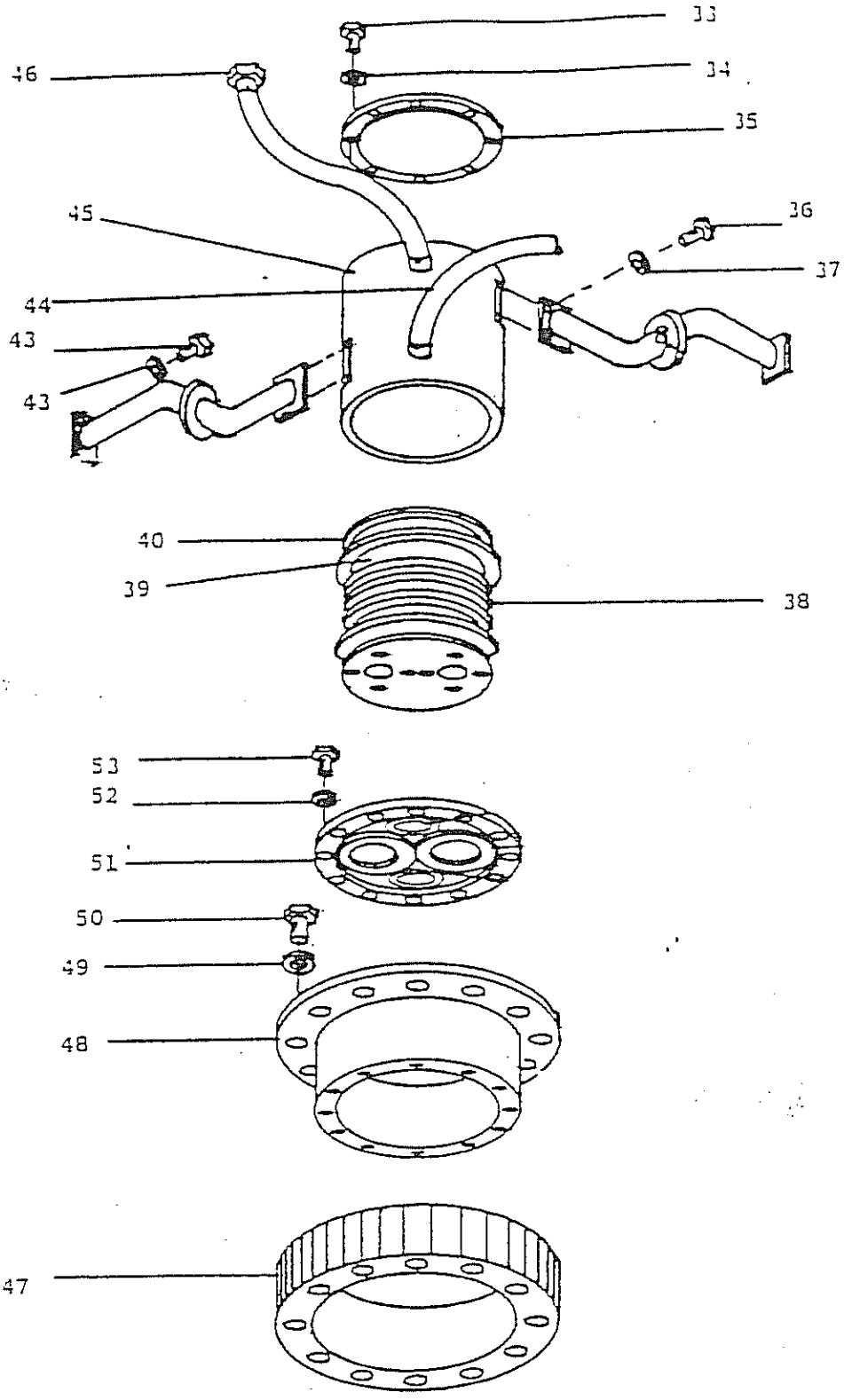


Figure 5-27 (3 of 3). Upper Outdrive Housing Assembly

37. Install plate (35).

38. Install washers (34) and bolts (33).

39. Install swivels (31) and (32).

40. Install drain plug (30).

41. Install pinion (29).

42. Install steering motor (para 4-49).

43. Install cover (27) and bearing (28).

44. Install washers (25) and screws (26).

45. Install washers (22) and bolts (23).

46. Install seals (20) and (21).

47. Install fitting (17).

48. Install washer (18) and screw (19).

49. Install bolts (16).

50. Install top cover (1).

51. Install washers (3) and bolts (2).

52. Install position indicator (para 4-50).

53. Install O-ring (15).

54. Position housing (7) and lower section (11) together.

55. Install washers (9) and bolts (10).

56. Connect hoses (8, 12, 13, and 14).

57. Install back cover (4).

58. Install washers (6) and bolts (5).

5-31. REPAIR/REPLACE LOWER UNIT ASSEMBLY

This Task Covers: a. Repair b. Replacement

INITIAL SETUP

Tools Required

Tool Kit, General Mechanics (Appendix B, Item 1)
Socket Wrench (Appendix B, Item 1)
Crescent Wrench (Appendix B, Item 1)
Special Puller (Appendix B, Item 1)
Nylon Strap

Equipment Conditions

Engine Shutdown (para 2-11).
Battery Disconnected (para 4-58).
Upper Housing Removed (para 5-30).

Materials/Parts Required

Cotton Rags (Appendix E, Item 3)
Packing P/N 2-278
Adapter P/N 848-FSO-12X12
Hose Assembly P/N E7HU0810RCNJ-84
Packing P/N P05054
Hose Assembly P/N N6ER202PH24PH-77
Packing P/N P05016
Pin P/N P06001
Propeller P/N D100410
Key P/N P06000
Seal P/N D100300
Fitting P/N P10004
Packing P/N 2-245
Seal P/N 12494LPD
Seal P/N 15672HP
Packing P/N 2-278
Hose Assembly P/N 10CIT-12FJX-8MP-98
Motor P/N D100408
Packing P/N 2-262
Coupling P/N C100407
Packing P/N C100414
Packing P/N P05050
Shim P/N K22005
Shim P/N K22007
Cong P/N HM813849
Shaft P/N D100299
Cover P/N D100314
Cover P/N D100310

Personnel Required

2 Persons

Swivel
  P/N 69520FB20-FB20
Swivel P/N 9S12J12-012
Swivel P/N 9S6J8-08
Packing P/N P05055
Packing P/N P05053
Hose Assembly
  P/N J4HU1212RC9010NJ-18
Adapter P/N 849-FSO-10X10
Packing P/N P05054
Hose Assembly
  P/N J4HU1212RC9012RC90-14.5-190
Tube P/N C100353
Swivel Assembly P/N D100326
Hose Assembly
  P/N J4HU0808RC9010RC90-10.5-30
Hose Assembly
  P/N JHU0808RC9010RC90-25.5-300
Fitting P/N P1004
Plug P/N P10007
Cap P/N MS25043-18D
Connector P/N MS3102R-18-12S
Motor P/NRE240804
Key P/N P06002
Link P/N P08043
Chain P/N P08042
Shaft P/N C100324
Indicator P/N P04130
Cylinder Assembly
  P/N TH5036048PA-00
Packing P/N 10033
Cup P/N 10026
Packing P/N 10053
Retainer P/N 10085
Ring P/N 10714
Seal P/N 10008

REPAIR Repair is limited to the replacement of defective parts.

REPLACEMENT (Figure 5-28.)

1. Loosen and remove bolts (1).
2. Remove outdrive stem (2) using hoist and nylon strap.
3. Using special crescent wrenches, disconnect hose (3) and hose (4).
4. Using special socket wrench, disconnect hose (5).

5. Cover hose ends with tape or other material to prevent contamination.

6. Remove cotter pin (26).

7. Remove jam nut (25) and prop nut (24).

8. Remove propeller (23) using special puller tool and key (6).

9. Remove bolts (22) and rope guard/seal assembly (21). Use tapped back-off holes if necessary.

10. Remove seals (7) and (8) from seal housing (21).

11. Remove bolts (9) and lockwashers (10) from bearing housing (20).

12. Remove complete power module assembly from lower housing.

13. Remove bolts (28) and lockwasher (27). Pull assembly apart.

14. Remove bolts (18) and washers (17).

15. Remove O-ring (38).

16. Pull prop shaft (13) from assembly.

17. Remove bearing retaining ring (16), shims (15) and bearings (14), outer race).

18. Press bearing (19) (inner race) off shaft.

19. Press bearing (12) (inner race) off shaft (13).

20. Tap bearing (11) (outer race) from housing (20).

21. Remove bolts (32) and lockwashersw (31) from motor (33).

22. Remove bolts (30) and lockwashers (29) from flange (35) and gear (37).

23. Remove O-ring (34), and gasket (36).

24. Replace O-ring (34) and gasket (36).

25. Install bolts (30) and lockwashers (29) into flange (35) and gear (37).

26. Install lockwashers (31) and bolts (32) into motor (33).

27. Install bearing (11) (outer race) onto housing (20).

28. Press bearing (12) (inner race) onto shaft (13).

29. Press bearing (19) (inner race) onto shaft.

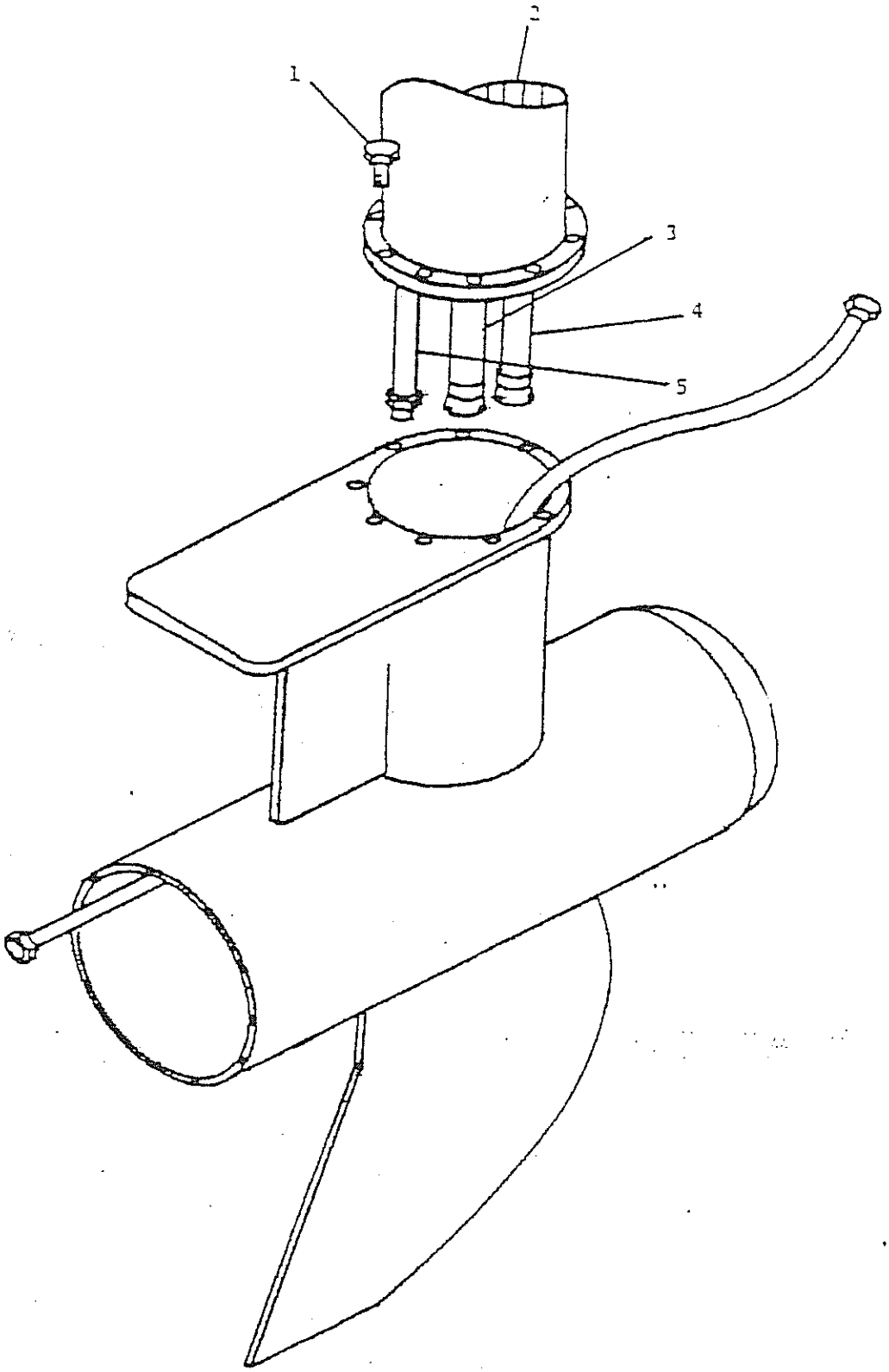


Figure 5-28 (1 of 3). Lower Unit Assembly

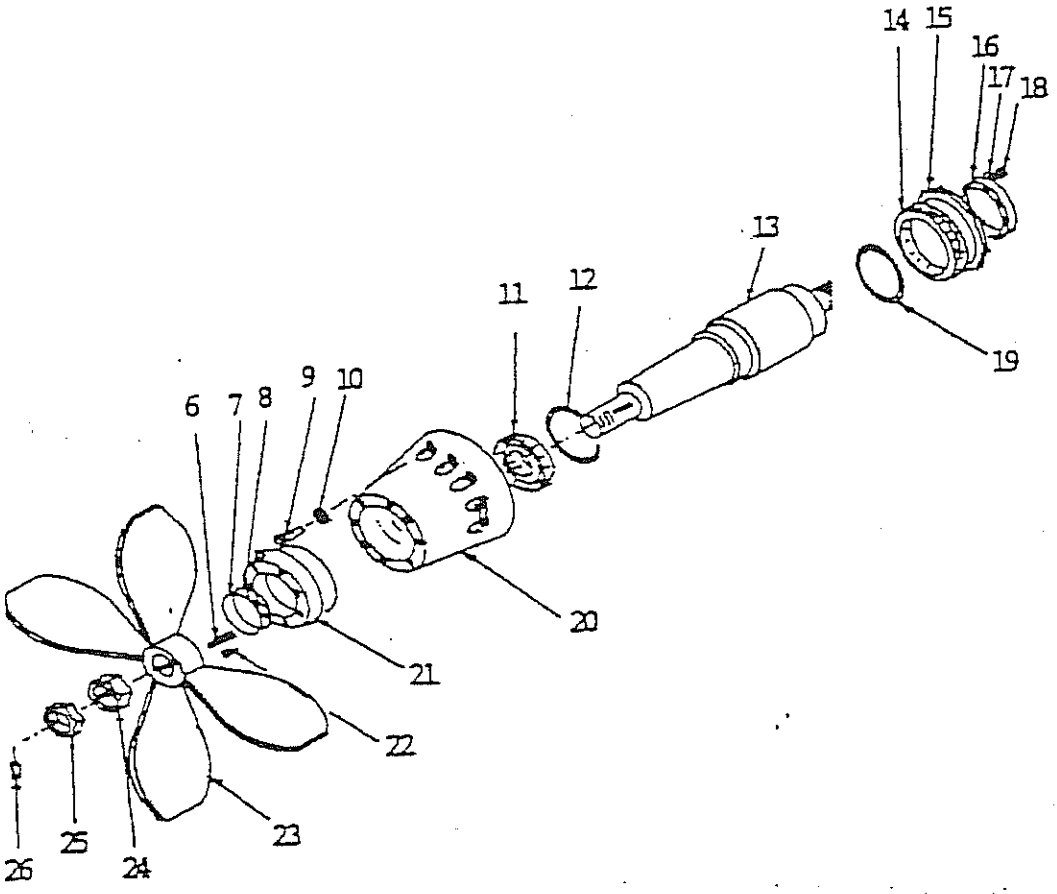


Figure 5-28 (2 of 3). Lower Unit Assembly

QTY.	PART NO.	DESCRIPTION	PRICE, EACH
1	P16051	HYDRAULIC COOLER	31.73
1	P08071	PUMP DRIVE PLATE	573.50
1	P03220	MAIN HYDRAULIC PUMP	5,651.68
1	P03183	AUXILIARY HYDRAULIC PUMP	273.21
1	P05027	O-RING, AUX. HYDR. PUMP	1.75
1	P04278	HYDR. LEVEL SWITCH	93.00
1	P03124F	CHARGE FILTER ELEMENT	64.85
1	P03072	RETURN FILTER ELEMENT	78.70
1	P03155	KICK-UP SOLENOID VALVE	326.50
1	P03139	STEERING	129.00
1	PO3139	STEERING SOLENOID VALVE	355.00
1	PO3178	KICK-UP TANK RELIEF	129.00
1	P03094	LOOP FLUSHING VALVE	452.201
1	P03086	SHUTTLE VALVE	66.40
1	PO1050	EXHAUST MUFFLER	548.00
1	P04410	OIL PRESSURE SENDER	29.85
1	P04408	COOLANT TEMPERATURE SENDER	25.10
2	C100361	KICK-UP PIVOT BEARING HOUSING	293.50
2	PO8038	KICK-UP PIVOT BEARING	110.00
2	PO8044	KICK-UP PIVOT THRUST WASHER	58.00
2	P03049	KICK-UP CYLINDER	1,426.00

All quantities are per propulsion unit.

QTY.	PART NO.	DESCRIPTION	PRICE, EACH
2	C100339	BASE END CLEVIS PIN	198.25
2	C100352	ROD END CLEVIS PIN	188.50
1	P05098	OUTDRIVE BUMPER	273.40
1	P05101	KICK-UP BUMPER	213.75
1	D100397	STEERING BEARING	1,765.00
1	P05010	OUTDRIVE COLLAR SEAL	180.00
1	D100363	COLLAR SEAL RETAINER	112.00
1	C100744	STEERING PINION GEAR	1,243.00
1	P08007	STEERING PINION BEARING	143.75
1	P05014	O-RING, PINION BEARING	1.25
1	P03097	STEERING MOTOR	574.10
1	C101787	MAIN SWIVEL ASSEMBLY	2,684.00
2	B100433	SWIVEL THRUST BEARING	25.00
2	B101596	LOWER AND UPPER SWIVEL SEAL	41.00
3	B101597	INTERMEDIATE SWIVEL SEAL	41.60
2	B100435	SWIVEL RADIAL BEARING	41.00
1	P04302	STEERING POSITION TRANSMITTER	984.30
1	P05004	PROPELLER SHAFT SEAL, INBOARD	165.38
1	P05005	PROPELLER SHAFT SEAL, OUTBOARD	23.27
1	D102017	PROPELLER SHAFT	2,574.00
1	P08052	OUTBOARD BEARING CONE	73.60
1	P08053	OUTBOARD BEARING CUP	45.25
1	P05015	O-RING STEM TO UPPER HOUSING	3.25
1	PO8103	INBOARD BEARING CONE	136.13
1	PO8104	INBOARD BEARING CUP	56.45
1	PO5123	O-RING STEM TO LOWER HOUSING	3.25

All quantities are per propulsion unit.

QTY.	PART NO.	DESCRIPTION	PRICE, EACH
1	B100825	BEARING SHIMS	8.25
1	P03219	PROPULSION MOTOR	3,390.00
1	P05023	O-RING, MOTOR	3.25
1	P02026	PROPELLER	3,724.00
1	P07016	PROPELLER NUT	46.00
1	P07017	PROPELLER JAM NUT	44.00
1	PO4560	POWER SWITCH	62.95
1	P04466	TACHOMETER	105.90
1	P04303	STEERING ANGLE INDICATOR	548.50
1	P04401	OIL PRESSURE GAUGE	48.75
1	P04403	WATER TEMP GAUGE	48.35
1	PO4105	20A FUSE	1.00
1	P03045	PRESSURE GAUGE, MAIN	51.35
1	P03044	PRESSURE GAUGE, CHARGE	49.00
1	P17022	PRESSURE GAUGE, AUXILIARY	49.60
1	PO4494	ENGINE THROTTLE ACTIVATOR	562.50

REVISIONS			
REV	DRN	CHK	APP
A	LJL	JRB	JRB
DATE: 04/23/02			
ADDED GPM & FILTER			

CHARGE GAUGE P03044
SNUBBER P16039
T
P
JOYSTICK CONTROLLER P03221
1
2
FILLER BREATHER P10152
RESERVOIR 85124105
CHARGE FILTER P03072
Y1
FA
Y2
M1
T3
R
POR SET @ 3000 PSI
MAIN PUMP ASSEMBLY P03220
PXT
PRESSURE TRANSDUCER P04559
128 GPM @ 3000 PSID
FE
A
LOOP FLUSHING VALVE P03094
SET @ 270 PSI
MA
CROSS PORT RELIEFS SET AT 3500 PSI
SNUBBER P16039
MAIN GAUGE P03045
SHUTTLE VALVE P03086
THRUSTER MOTOR P03479
5 GPM
AUXILIARY PUMP P03101
CHARGE
MAIN PUMP
M
MB
CHARGE RELIEF SET @ 320 PSI
B
5 GPM
S
X1
X3
X4
X2
T1
T2
T4
128 GPM @ 3000 PSID
27 GPM
8 GPM
HEAT EXCHANGER P16051
32 GPM
FILTER P03072
10 GPM
THRUSTER UNIT
PRESSURE REDUCING VALVE P03134
VALVE P16039
AUXILIARY PRESSURE GUAGE P017022
P
CONTROL VALVE ASSEMBLY MANIFOLD P03173
G
2000 PSI
T
5 GPM
P03155
P03139
3 GPM
P03151 3000 PSI
P03177
V1
C1
STEERING MOTOR P03097
BRAKE P03099
V2
C2
3 GPM
COUNTERBALANCE VALVE P03107
A1
B1
A2
B2
3000 PSI
1
G
2
P03178
1
5 GPM
KICKUP CYLINDERS P03628
5 GPM

THRUSTMASTER OF TEXAS, INC.

TITLE
SCHEMATIC—HYDRAULIC

PROJECT
U. S. NAVY

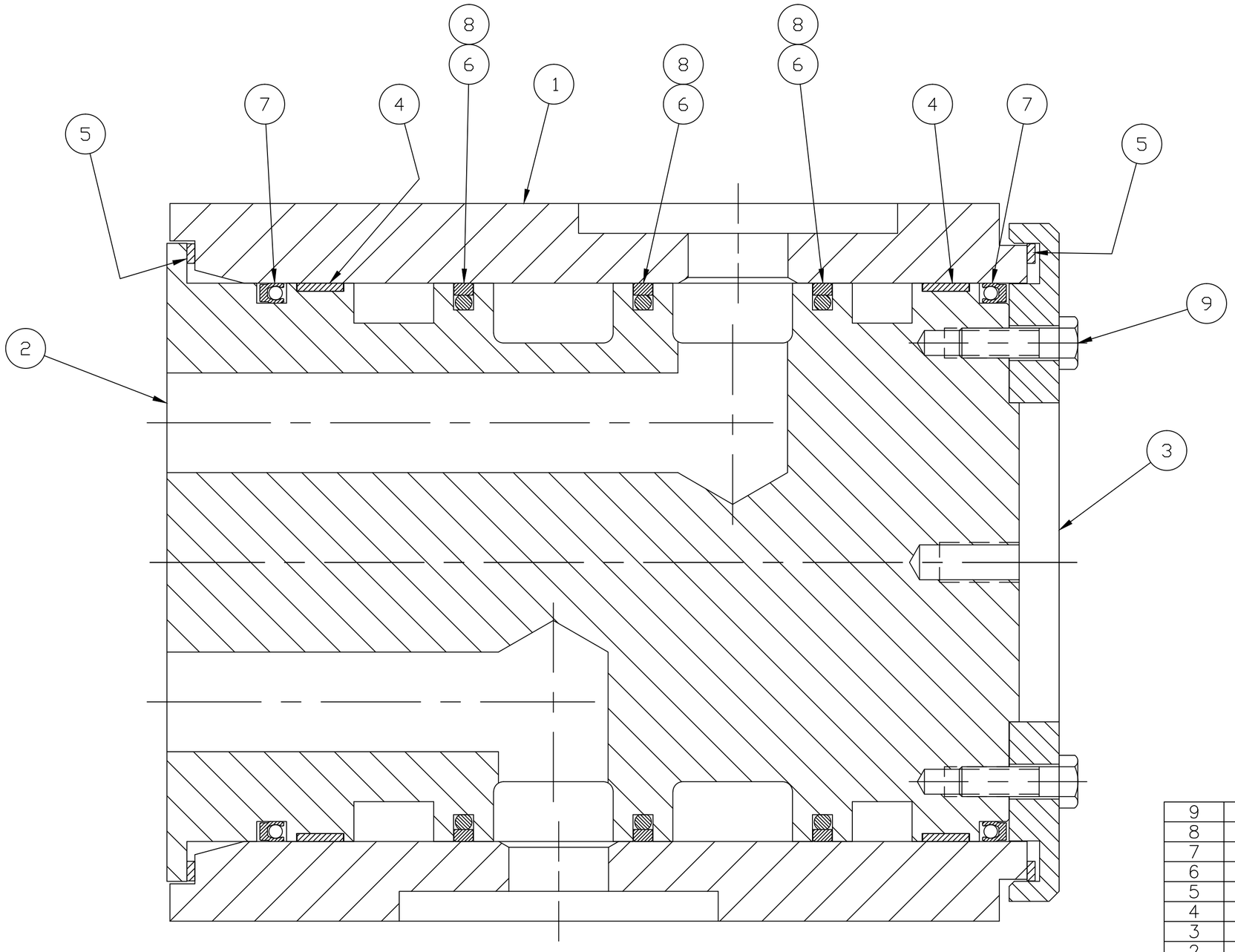
SIZE	CAGE NO.	DWG NO.	REV.
D	65848	D102037	A

TMOT JOB NO. Y010228/92092
DIMENSIONING CONVENTION INCHES (MM)
SCALE: NONE
DO NOT SCALE
THIRD ANGLE PROJECTION

	NAME	DATE
DRN	DHP	1/7/93
CHK	DHP	1/7/93
APP	JRB	1/11/93

EST WT.

REVISIONS			
REV	DRN	CHK	APP
A	JLG	JLG	JRB
DATE: 1/30/96			
QTY OF ITEM 6 WAS 5, P/N OF ITEM 7 WAS B101596			



FIND	QTY	PART NO	DESCRIPTION
9	8	----	HHCS .375-16UNC X 1.25, TEFLON
8	3	B101597	SEAL,INTERMEDIATE
7	2	P05209	SEAL,END
6	3	P05125	O-RING (#2-362)
5	2	B100433	BEARING,THRUST
4	2	B100435	BEARING,RADIAL
3	1	D100328	FLANGE,SWIVEL ROTOR 1.25"
2	1	D101599	ROTOR,SWIVEL 1.25"
1	1	D101598	BARREL,SWIVEL 1.25"

THIRD ANGLE PROJECTION

REMOVE ALL BURRS
REMOVE ALL SHARP EDGES

DO NOT SCALE

	NAME	DATE
DRN	JLG	3/26/92
CHK	JRB	3/30/92
APP	JRB	3/30/92

UNSPECIFIED TOLERANCES
. X = ±. 025
. XX = ±. 005
. XXX = ±. 005
SURFACE FINISH: 125 RHR
ANGULARITY: ±1°

ENG REF:

CONTRACT NO.

THRUSTMASTER OF TEXAS, INC.

TITLE: ASSY-SWIVEL,1-1/4"

SIZE	FSCM NO.	DWG / PART NO.	REV.
C	65848	C101787	A

MATERIAL

FINISH

SCALE: 1/1 | EST. WT. 145.0 LBS. | SHEET 1 OF 1

REVISIONS

CABLE CONNECTOR P04382 P04383

CABLE P04504

TERMINAL STRIP P04236

WHITE
ORANGE
GREEN
BLACK
BLACK 12
RED

WHITE 16
ORANGE 16
GREEN 16
BLACK 16
RED 16
RED 16
RED 16
RED 12
BLACK 16
RED 16
PINK 16
YELLOW 16
PURPLE 16
TAN 16
LIGHT GREEN 16
GREEN 16
BROWN 16
WHITE 16

YELLOW 16
PURPLE 16
PINK 16
TAN 16
LT. GREEN 16
GREEN 16
BROWN 16
WHITE 16

ORANGE 16
ORANGE 16
PURPLE 16
PURPLE 16
RED 16
BLACK 16

BLUE–BLACK
ORANGE
YELLOW–BLUE
BLACK
BLACK–RED
RED
RED–BLACK
YELLOW
BLUE–RED
RED–BLUE
YELLOW–BLACK
BLUE–ORANGE
BLACK–ORANGE
BROWN
YELLOW–ORANGE
ORANGE–BLACK
ORANGE–RED
BLUE
ORANGE–BLUE
RED–ORANGE
BROWN–BLACK

FUSE 20A P04105 P04350

PRESS. X–DUCER P04559

AMMETER P04397

CABLE P04430

CONNECTOR P04429

WHITE
ORANGE
GREEN
BLACK
RED

STEERING ANGLE TRANSMITTER P04302

VOLTAGE REGULATOR

ALTERNATOR

STOP RELAY P04326

START RELAY P04326

STOP SOLENOID P04365

C/W TEMP SENDER/SWITCH P04408

L/O PRESSURE SENDER SWITCH P04410

ENGINE RELAY

START SOLENOID

STARTER

BATTERY 12 VDC P04322

AIR BOX SOL

C/W TEMP SWITCH CLOSE @ 225°F

L/O PRESS SWITCH OPEN @ 6 PSI

FUEL SWITCH CLOSE @ 12 PSI

HYDRAULIC OIL LEVEL SWITCH P04278

KICK UP VALVE P03155

STEERING VALVE P03139

THROTTLE ACTUATOR P04494

THROTTLE JOG STICK P04443/ P04394

STEERING JOY STICK P04115

KICK–UP PUSHBUTTON P04524/ P04393

KICK–DOWN PUSH BUTTON P04524/ P04393

TACH P04466

OIL PRESS GAUGE P04401

C/W TEMP GAUGE P04403

THRUST GAUGE P04550

START PUSH BUTTON P04395/P04393

STOP PUSH BUTTON P04394/P04393

ALARM LITE
HI C/W TEMP P04421/3

ALARM LITE
LO L/O PRESS P04421/3

POWER SWITCH P04560/P04393

STEERING ANGLE INDICATOR P04303

LOCAL INSTRUMENTS

CONTROL PANEL

THRUSTMASTER OF TEXAS, INC.

TITLE: SCHEMATIC–ELECTRICAL

PROJECT: 92092

SIZE	CAGE NO.	DWG NO.	REV.
D	65848	D102069	

TMOT JOB NO.

DIMENSIONING CONVENTION: INCHES (MM)

SCALE: DO NOT SCALE

THIRD ANGLE PROJECTION

	NAME	DATE
DRN	DHP	1/28/93
CHK	JLG	2/23/93
APP	JRB	2/26/93

EST WT.

SHEET 1 OF 1